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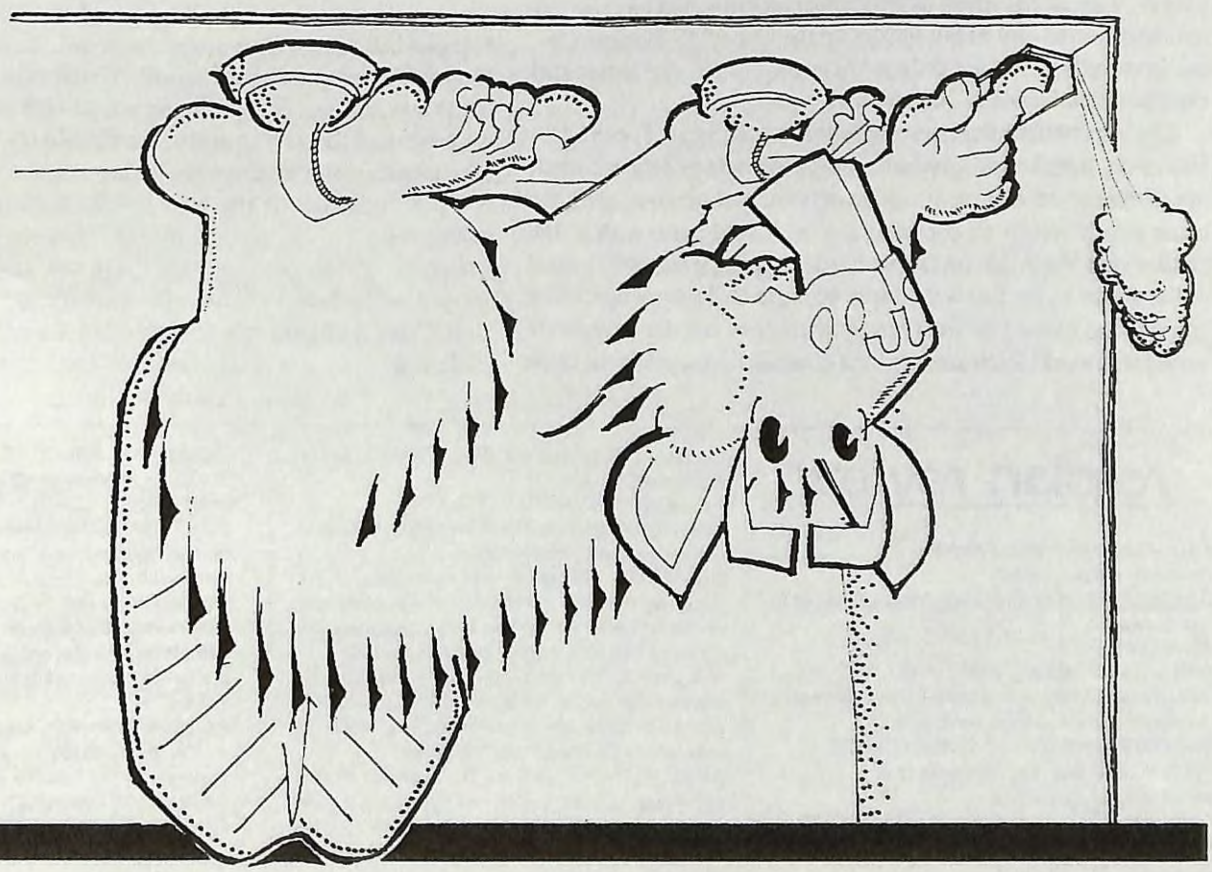

From the Editor . . .

You can argue whether the millennium has already started or starts next year. For many, it started as the calendar page was turned to January 1 of this year. By now you may be tired of year-end stories overlaid with the "best of" the century/millennium. Year-end stories are a lazy journalistic trick to fill space during a slow time of the year for news. However, this year is different because, as we turned the calendar page, we crossed a psychological threshold.

The beginning of the year 2000 gives us the chance to contemplate how much has changed in recent years. The 20th century has changed the world in a way we don't yet fully understand. I look at the changes my parents, who are still alive, have witnessed. They were born a few years before the start of the First World War, into a world without air travel, radio and television, automobiles, not to mention computers, the Internet, faxes, and the many other products we now take for granted. The changes are astounding when you consider they took place within a single human lifetime. These changes have also had a profound impact on our industry.

In the last one hundred years, transportation systems have changed. I am not only referring to air travel, which has put the furthest part of the world within a day's reach of any other place. In cities, the private automobile has been both a blessing and a plague. The car has given us freedom of mobility, but has also led to urban sprawl and its big impact on the type of development we are involved in. We are only now starting to pay the social and environmental costs of such sprawl.

The telecommunications revolution, which started with wireless radio, telephones, television and computers and the Internet, are all recent developments. In an extremely short time, we have come to rely totally on computers. We all held our breath as the clock struck midnight on December 31, hoping it was not the end of the world as we know it simply because of the computer. The anxiety was caused by worry over whether or not our computers would still work! Such anxiety over dumb machines! Maybe there already is an artificial cyber intelligence, and we have become its slaves?

The communications revolution has changed the way most of us work. Remember the days before faxes and cell phones? It was not that long ago - but try to think about a job site without access to these.

The way we use energy has changed. We no longer rely on inefficient, dirty coal, wood or sawdust burners for our primary heat. We have much cleaner, more efficient equipment available, but use more energy in the process.

The way we build has changed. Our homes are much more comfortable than in the past. Central heating and cooling, indoor plumbing, household appliances, entertainment packages have all changed the style and design of our buildings, and are now taken for granted. New materials we cannot do without, such as plywood, drywall, high performance windows, engineered wood beams, PVC and new insulation products - have changed what and how we build.

We are dazzled by products and technologies. However, we don't give enough consideration to what it is we are doing, and why. We forget that, just because these new products and technologies are available, the basic principles of physics have not changed . What we often have problems with is the inadequate evaluation the new products receive and the consequences of using these products on the buildings we construct.

In the past, the pace of change was slower, so there was opportunity to evaluate the impact of new products and technologies before they became widespread. Today, we don't seem to be able to make that evaluation. We rush into the exploitation of the new, and suffer the consequences if there is a screw up. As we move into the new century, we should try to slow down, and take measure of where we are today.

To all readers, all the best for the new year, and the next millennium.

Richard Kadulski
Editor

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Building Science 101: Air Barriers

Air movement is the major factor in transporting moisture through building envelope assemblies. Many building envelope problems can be attributed to inadequate or failed air barriers.

The National Building Code of Canada has required air barrier systems since 1960. Unfortunately, there is considerable confusion between what is an air barrier and what is a vapour barrier. The two are distinct functions that, in some situations, may be satisfied by the same material components. In 1990, the wording of Part 9 of the Code was modified to clarify and separate the functional requirements for air barrier systems and vapour barriers. The Code now requires that the air barrier system provide an effective barrier to air exfiltration under differential air pressure due to stack effect, mechanical systems and wind.

The Air Barrier

The air barrier system is fundamental to the control of air, heat and water vapour flows. It also plays an important role in controlling rain penetration and external noise transmission.

The Code recognizes that the material in the air barrier system that provides the main resistance to air movement and the vapour barrier may not be the same. If the functions are separated, the vapour barrier alone does not have to be perfectly continuous. Nor does it have to meet the structural requirements of air barrier systems.

A vapour barrier resists the *diffusion* of water vapour through the pores of a material. The driving force to move the water vapour is a difference in vapour pressures, from an area of high vapour pressure to one of low vapour pressure.

An air barrier, on the other hand, resists *air movement* and must have structural strength to resist the air pressures acting on the building, which can be substantial in strong winds. A vapour permeable material that, in relative terms, is a sieve to vapour, may do a good job resisting air movement. However, defining performance requirements for air barrier systems is not a simple undertaking.

Significant air leakage may result in condensation within an assembly which, in turn, can lead to mould growth, a potential health hazard.

A well designed and built air barrier system must be airtight, continuous, structurally capable of withstanding the air pressures on the building envelope and constructed with materials that are durable, or at least maintainable. Air barrier systems are usually built using different airtight materials joined with tapes or sealants to provide continuity over the entire building envelope.

The air barrier must be built of airtight materials

The material that provides the principal resistance to air leakage within the air barrier system must have an average leakage characteristic not greater than 0.02 L/(s·m^2) at 75 Pascals (Pa) pressure difference. (This represents the leakage rate, for example, through a 12.5-mm sheet of unpainted gypsum wallboard); although pressure differences across the building envelope are often much higher than the 75 Pa benchmark used for test purposes.

> The air barrier system is fundamental to the control of air, heat and water vapour flows.

The air barrier must be continuous across the building envelope

The leakage of moist, heated interior air into cold spaces of building envelope assemblies is a far more significant cause of problems resulting from condensation than the diffusion of water vapour. The most important function of a wall air barrier system is to control the flow of air into and through a wall, so that condensation is rare or the quantities of water accumulated are small, and drying is rapid enough to avoid the deterioration of materials or the growth of moulds and fungi.

The air barrier must be strong enough to resist wind pressures

Over the life of the building the air barrier will be subjected to pressure differentials caused by stack effect, wind and possibly fan pressurization. From a structural point of view, stack effect pressures are small: typically, less than 20 Pa in a low-rise building. Pressures at 1,000 Pa or more may be induced by wind, but because of the short term duration these pressure differentials are generally less important when considering the air leakage. However, when an air barrier is being designed, wind load conditions must

> A well designed and built air barrier system must be airtight, continuous, capable of withstanding the air pressures on the building and built with durable and maintainable materials.

be considered in addition to materials as these may affect how the different materials are attached.

The air barrier must be strong enough to resist the air pressure loads imposed on it, transfer these loads to the building structure and have enough rigidity or support under imposed loads. The wall design must accommodate the deflection of the air barrier under a full load, and it must also allow some margin for construction tolerance.

A flexible membrane must be supported on the framing system so that it can resist lateral loads. How well it works depends on the ability of the membrane and joints to resist tensile force. This requires that joints in the membrane and to adjacent construction be detailed to provide the required strength.

The National Building Code of Canada requires an air barrier system to resist both sustained wind loads lasting up to one hour and higher gust wind loads lasting from three to five seconds. If pressures are put on an air barrier system that has not been properly designed, damage could result in increased amounts of air leakage over the life of the building. Ultimately, this could cause the air barrier system to lose structural integrity.

The air barrier must be durable

The air barrier must be durable enough to provide the necessary performance in the anticipated environment. Different deterioration mechanisms that should be considered over the expected service life of the air barrier components, including structural loading, freeze/thaw, differential movement, ice lensing, corrosion, solar radiation exposure, biological attack, and intrusion by insects and rodents. The durability of an air barrier system also depends on compatibility with adjacent materials and the loads to which it is subjected to over its service life.

Incompatibilities between materials must be considered. For example, polyvinyl (PVC) and asphalt-based materials are not compatible in contact with each other. Similarly, polyethylene and asphalt-based materials react with each other, as do polystyrene and asphalt-based cutback materials.

The air barrier must be buildable

A construction review provides the last opportunity to find and resolve problems with continuity and structural support factors that were not noted during the design. The review should emphasize the continuity at all joints and interfaces, attachment methods, and fastener spacing.

One highly recommended practice is the use of construction mock-up sections. This is especially valuable on larger projects. Typical areas of the wall system which include common connection details are designated as mock-up sections. The mock-up construction can be closely supervised, inspected and tested if necessary.

These mock-up sections are often left as part of the finished building or may be retained separate from the building to serve as a reference throughout the construction stage. Increasingly, this is becoming common practice on multi-family projects in coastal B.C.

How tight do air barriers have to be?

There are relatively few published data about leakage of the air barrier system as a whole. Very airtight or very leaky walls generally will not have a problem, but walls with an intermediate level of airtightness may.

The air leakage performance of materials, as specified by the code, does not automatically translate into airtight building envelopes, as much will depend just how the materials are assembled. Air leakage of selected materials has been tested (results have been summarized in the table, page 5).

Several typical walls have been tested under both negative and positive pressure differentials. Most of the air barrier systems tested would meet the air leakage rates required by the Building Code in most Canadian cities. Several air barrier systems were airtight but failed during the wind gust loads. In most cases, a tighter nailing schedule or the use of nails with larger heads or strapping would solve the problem.

Leakage points can be found simply by creating a pressure difference across the construction assembly and using a smoke pencil. Smoke-testing, however, does not measure the flow.

The Canadian Construction Materials Centre (CCMC) has developed an evaluation process for air barrier systems, which relies heavily on testing of sample specimens of air barrier systems. However, the tests are done on small sections, and will not necessarily reflect total building conditions.

A whole-house airtightness test, such as used to test for compliance with R-2000 requirements, or used by the EnerGuide program does not provide

measurements that can be directly compared with the system air leakage rates identified in the code or CCMC evaluation criteria. Typical results from such whole-building airtightness tests provide air leakage rates per unit area that are much higher than the recommended system air leakage rates. This is because a large proportion of the leakage is through elements other than the insulated portion of the building envelope. However, specifying whole-building airtightness testing in commissioning procedures may encourage designers and builders to pay attention to airtightness details but the results cannot be directly related to the system requirements identified in the NBC.

Air Barrier Joint Materials

Air barrier systems will usually be built from different materials joined with tapes or sealants to provide continuity over the entire building envelope.

The effectiveness of the air barrier system depends to a large extent on the joints between materials. It is important that the joints provide an acceptable level of airtightness under whatever air pressure the air barrier is exposed to, and the joints must maintain their airtightness over time.

Laboratory tests give us an indication how different materials behave over time under various pressure and temperature differentials. A number of samples were tested at a pressure differential of 150 Pa., and temperature of -20°C, +20°C and +65°C. These conditions are representative of those experienced by the air barrier at the top of a 20-storey building. The findings are useful when selecting joint materials in an air barrier system.

-20°C. was selected as representative of the cold temperatures to which an air barrier on the exterior of the insulation might be exposed; +65°C is representative of the hot temperatures to which an air barrier on the exterior of the insulation might be exposed; and 20°C is representative of the conditions on the interior.

The test conditions were maintained continuously for five months, or until the airtightness of the sample was lost. Results on selected products are presented here.

Air Leakage Rate, Selected Materials

Material	Air Leakage Rate (*l/s-m² @ 75 Pa*)
Smooth Surface Roofing Membrane, *2 mm*	Non-measurable
Aluminum foil vapour barrier	Non-measurable
Bituminous Torch-On Membrane *2.7 mm*	Non-measurable
Plywood Sheathing *9.5 mm*	Non-measurable
Extruded Polystyrene, *38 mm*	Non-measurable
Foil Back Urethane Insulation, *25.4 mm*	Non-measurable
Cement Board, *12.7 mm*	Non-measurable
Plywood Sheathing, *8 mm*	0.0067
Gypsum Board, *12.7 mm*	0.0196
Expanded Polystyrene, Type 2	0.1187
Non-Perforated Asphalt Felt, 15 lb.	0.2706
Rigid Glass Fibre Insulation Board with a Spun Bonded Olefin Film on One Face	0.4880
Plain Fibreboard, *11 mm*	0.8223
Spun Bonded Olefin Film (1991 product)	0.9593
Expanded Polystyrene, Type 1 *(25 mm)*	12.2372
Tongue and Groove Planks	19.1165
Glasswool Insulation	36.7327
Cellulose Insulation, Spray-On	86.9457

The National Building Code requires that materials forming part of an air barrier assembly should not exceed an air leakage rate of 0.02 l/s-m² @ 75 Pa

Closed Cell Backer Rod

The use of closed cell backer rods is not recommended. Despite their satisfactory airtightness; most of the leaks occur at the end of the joints in the backer rod. Due to contraction and/or loss or compression over time, the leaks tend to increase. In one case, the increase in leakage was due to backer rod that stretched during installation, then shrank back to original shape.

Open Cell Gaskets

Open cell gaskets are not recommended because of their poor airtightness. The low rate of compression caused two gaskets in one sample to pop out after only eight days. The open cell gaskets became slightly more airtight during the test because of the accumulation of dirt in the cells of the gasket.

Mineral Wool

Although mineral wool is a good insulation material, it is not suitable for air barriers. Mineral wool, like open cell gaskets, acts as a dust filter.

EPDM Gaskets

EPDM gaskets have good airtightness and stability properties, but the efficiency of the joint depends to a great extent on its installation, with airtightness at the ends of the joints being critical.

Urethane Foam

The urethane foam was not affected in any way by the tests. The foam is expected to be more effective in large joints than in smaller joints, like the one tested. In small joints, small cracks or voids can be formed that leave space for the air to circulate.

Adhesive Tape

Even when attempts were made to remove adhesive tape, it showed great adherence on all surfaces tested, including water-resistant drywall, olefin paper and perforated polyethylene.

Spun Bonded Olefin

The spun bonded olefin paper provided good initial airtightness but quickly had problems under high temperatures. It seemed to lose its property to stretch and, under pressure, broke away from the staples holding it in place. This problem did not occur at ambient or low temperatures.

Perforated Polyethylene

This air barrier material is a plastic membrane perforated with thousands of small holes, which supposedly allow water vapour diffusion but actually prevent air leakage. However, the material itself was found to be permeable to air. That the airtightness improved over the test was due to dust blocking the holes.

Acrylic Sealant

Acrylic sealant was found to deteriorate rapidly under high temperatures but showed no deterioration under ambient or low temperatures.

Silicone Sealants

Silicone sealant did not show any weakness during testing, with the exception of a slight change in colour. It appears to be a good choice for joints in an air barrier system.

Conclusions

Silicone based sealants and adhesive tape achieved the best performance under all conditions.

Spun bonded olefin paper and acrylic base sealants should not be used at connections where the temperature may be hot. Staples to attach the spun boned olefin should be avoided. Because of their high air permeability, open cell gaskets, mineral wool and perforated polyethylene membranes should not be used.

The use of closed cell gaskets is not recommended because of problems with leakage at the ends and possible problems with long-term performance.

References:

Air Barrier Systems for Walls of Low Rise Buildings: Performance and Assessment, 1997, National Research Council of Canada *(This illustrated publication was developed for the Canadian Construction Materials Centre (CCMC) and is an excellent, higly recommended, review of the subject, written in a very clear manner. Copies are available from the NRC).*

Testing of Air Barrier Systems for Wood Frame Walls, *1988; National Research Council for Canada Mortgage & Housing Corporation.*

Air Permeance of Building Materials, *1998; Air Ins. for Canada Mortgage & Housing Corporation.*

Airtightness Tests on Components Used to Join Different or Similar Materials of the Building Envelope. *Ain-Ins Inc. for Canada Mortgage & Housing Corporation.*

New Zealand: Durability expectations.

New Zealand's Building Code requires a service life of 50 years for structural elements and hidden anchors within the building envelope and between 5 and 25 years of service life, depending on the ease of access, for other building elements.

Air Leakage of Air Barrier Assemblies

A well designed and built air barrier system must be airtight, continuous, structurally capable of withstanding the air pressures on the building envelope and constructed with materials that are durable, or at least maintainable. Air barrier systems are usually built using different airtight materials joined with tapes or sealants to provide continuity over the entire building envelope.

Over the life of the building the air barrier will be subjected to pressure differentials caused by stack effect, wind and possibly fan pressurization. From a structural point of view, stack effect pressures are small: typically, less than 20 Pa in a low-rise building. Pressures at 1,000 Pa or more may be induced by wind, but because of the short term duration these pressure differentials are generally less important when considering the air leakage. However, when an air barrier is being designed wind load conditions must be considered besides materials as these may affect how the different materials are attached.

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How tight are typical wall assemblies?

The air leakage performance of several typical walls has been tested under both negative and positive pressure differentials. Most of the air barrier systems tested would meet the air leakage rates required by the Building Code in most Canadian cities. Several air barrier systems were airtight but failed during the wind gust loads. In most cases, a tighter nailing schedule or the use of nails with larger heads or strapping would solve the problem.

The performance of the overall building envelope will depend on all the other construction details used. For example, windows, doors, connections between different assemblies, and other penetrations of the envelope will be critical to maintain the airtightness of the envelope.

Measured Air Leakage Rate of Constructed Assemblies

Assembly	Air Leakage Rate *l/s-m²@75 Pa*
Fiberboard/Tyvek/Strapping Fiberboard sheathing nailed to the wood structure with 1¾" galvanized roofing nails at 6" o.c., Tyvek stapled to the fibreboard every 4 ft., vertical wood strapping nailed to the perimeter and face of the studs with spiral nails at 12" o.c.	0.488
Glasclad/3M tape Glasclad insulation board nailed to the wood structure with 2½" spiral nails with 1" sq. plastic washers, and 3M construction tape over the vertical joints and perimeter.	0.300
Extruded Polystyrene/3M tape Shiplap edge, extruded polystyrene insulation nailed to the structure with 2½" spiral nails with 1" diameter metal washers every 6" along the edges and 12" along the intermediate supports, with 3M construction tape over joints.	0.002
Dryvit Wall Panel Prefabricated wall panel: steel stud structure, exterior gypsum board, expanded polystyrene insulation and a synthetic exterior finish.	0.003
Gypsum/Joint Compound Gypsum board (½") attached horizontally to the wood structure with 1¼" drywall screws every 8" along edge supports and 12" along intermediate supports, with two coats drywall joint compound and paper tape and surface-painted with two coats of latex paint.	0.002
Plywood Skin Panel Plywood skin glued with subfloor adhesive to 2x4 wood studs at 2 ft. o.c. with a single top and bottom plate and 1¼" drywall screws at 6" o.c. The 2½" glass fibre batt insulation against the inner plywood in the cavities left a 1" air space between it and the outer plywood.	0.004
Fiberboard/Polyurethane Foam Asphalt impregnated fiberboard (7/16") nailed to wood structure with 1¾" galvanized roofing nails at 6" o.c. along the edges and 12" o.c. along intermediate supports; stud cavities filled with at least 3" of standard density spray-applied polyurethane foam insulation cut flush to the face of the studs.	0.019
Fiberboard/Polyethylene/Gypsum Non-asphalt impregnated fibreboard (7/16") installed vertically with 1¾" galvanized roofing nails every 4" along edges and 8" along the intermediate supports; 6-mil polyethylene film with 4" overlap at the centre, stapled to fiberboard with ¼" staples every 2 ft. o.c., ½" horizontal gypsum boards installed on the polyethylene with 2" drywall screws every 8" along edges and 12" along intermediate supports. The gypsum was not sealed.	0.006

Regulatory Reform in Australia

Like death and taxes, regulations are something we would like to do without, but in reality have to face constantly. In recent years, the burden of regulation seems to get heavier. Bureaucracy and "liability chill" further overlay the process by which regulations are administered.

Canada faces many of the same challenges that stimulated interest in reform of the Australian building regulations. Seemingly limitless liabilities are a major concern especially to municipalities, which are seen to have 'deep pockets' and are frequently the main targets in building disputes.

Australia is making radical changes in the way building regulations are administered. The Australian reforms, which started in the early 1990s, appear revolutionary. When you see what the Australians have done, it makes you question why such innovation isn't being discussed here. Like in Canada, building regulation is a state responsibility in Australia. The pace-setter down under is the state of Victoria.

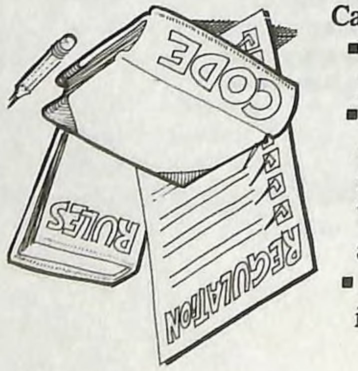
We should take the opportunity now to review how our Canadian regulatory system can learn from the Australian experience. We hope that a discussion can be started.

The building sector is not the only one affected by regulations and liability chill concerns. The restricted activities in many social organizations, from scouting to sporting groups, where few take any action without signed waiver forms, are some examples. The decline in investigative journalism is another high profile example. Everyone is afraid of getting sued, so decisions are made on the basis of how they can stand up in court.

If we are going to use our resources efficiently, we should be open to discussing the way we work. It may even lead to more innovative ways to build.

Paranoia over liability is not just a North American phenomenon; it seems to be a worldwide. However, some people are trying to do something about it.

The Australian reforms represent a useful starting point to examine possible ways of addressing many of the challenges facing the Canadian building industry today. The Australian reforms were designed to address challenges that seem similar to Canada's:



- The costly and lengthy building approvals process;
- Liability implications for builders, architects, engineers and building officials resulting from recent legal cases, especially builder liability for "economic losses," joint and several liability, and a perpetual liability for negligence.
- Attempts by municipalities to limit their liability for inadequate inspections
- The implications of new objective-based codes
- Regulatory obstacles to innovation
- Interprovincial barriers to trade and the movement of skilled workers
- The absence of professional designation and accreditation for people with key skills (e.g., building inspectors)
- Concerns about consumer protection and the adequacy of home warranty coverage
- bogus owner-builders who avoid many of the constraints applied to legitimate builders
- Increased underground activity in construction
- The lack of quality assurance approaches in building, and
- The need to enhance the professionalism of the building industry.

The reforms were introduced as a package that presented an integrated approach to building regulations recognizing that each part is dependent on the other parts. For example, compulsory insurance of building certifiers is a critical element in the privatization of building approvals to ensure there are enough funds to repair any building defects resulting from the private certifiers' errors or omissions. At the same time, limitations on liability are essential if the premiums for insurance coverage are to be reasonable. Registration and insurance for other types of building practitioners is necessary if, under the change, there is to be justice to proportional liability (i.e., it is necessary to ensure that all defendants have the resources to pay their proportionate share of damages).

The main elements of the regulatory reform package include the following points:

Limitation on liability for building practitioners

The liability period for property damage resulting from defects in the design, construction, approval or inspection of buildings has been capped at 10 years. In addition to the 10-year cap, 'joint and several' liability has been replaced with 'proportionate' liability according to the involvement of defendants - no party is required to cover more than their share of the damages. The 10-year cap does not extend to claims for personal injury or death, which may result from building defects.

The liability reforms were essential components of the regulation changes. Without clarity with respect to liability, it was considered to be impossible for insurers to quantify risk (and therefore establish an appropriate level of premiums).

When considering what an appropriate limitation period should be, it was considered that there be:

- Enough time to establish clearly when the limitation period should start.
- A long enough period for most defects to become apparent;
- A sufficiently limited period for it to be practicable to obtain insurance coverage for the whole period;
- Not so long a period that records and witnesses become unavailable or unreliable.

A 10-year period was considered appropriate based on evidence from various sources that virtually all serious building defects are detected within 10 years of completion of a structure.

Privatization of building approvals and inspections

Building approvals may now be obtained from private sector building certifiers. This replaces the traditional monopoly of local government building officials and has led to competition between private building certifiers and municipal building certifiers. Municipal building certifiers are also allowed to issue building approvals for projects outside of their local government area. Building certifiers examine plans to ensure they conform to appropriate codes and standards and other regulations, issue building permits, carry out inspections (where necessary), and issue occupancy permits. When private sector building certifiers are used on a building job, the municipal role is essentially reduced to one of keeping records of the final documents.

For larger builders and developers (especially those involved in commercial and large-scale residential construction), building certifiers have become part of the 'project team' for the design and development of new buildings. Rather than the sometimes adversarial approach where the design team operates separately from the certification function, privatization makes it easier to involve the certifier in all stages of a project (including the early design stage). This ensures that the certifiers' expertise is more fully utilized and costly redesigns are minimized.

However, while authorities encourage the involvement of certifiers as part of the design team, they are required to be 'third parties' to the process - they are not allowed to be in the direct employ of either the company that designed the building or the builder.

Once appointed, a certifier cannot be terminated without the written consent of the licensing body. The intention here is to protect the certifier against undue influence from the owner.

Compulsory registration of building practitioners.

All persons who undertake the design, construction or demolition of buildings (including building certifiers and inspectors) are required to register annually and receive a licence that allows them to undertake work anywhere in the state. There are a number of categories of building practitioners; building certifiers, inspectors, engineers, architects, designers, drafts people, commercial builders and residential builders with varying qualifications and experience required for registration in each category. Proof of a current insurance policy is also a requirement for registration. In the state of Victoria, anyone who contracts to undertake building work for a building owner (new work or renovations) which is valued at $5,000 or more must be registered with the Building Practitioners Board.

Subcontractors are not required to be registered as building practitioners unless they engage in work directly for a building owner, and the work is valued at $5,00 or more.

Only individuals can be registered as building practitioners. Any company wanting to build in the state of Victoria must have at least one registered building practitioner (of the appropriate type) as a partner or director.

Compulsory insurance for building practitioners.

Building practitioners are required to carry insurance to cover defects in the building work. The type of insurance required depends on the specific profession of the practitioner. Home builders are generally required to have job-specific insurance coverage. The purpose of the compulsory insurance is to ensure that there are enough resources available to cover the practitioners' share of liability in the event of claims for damages.

Owner-builders are not generally required to be registered as building practitioners unless they are in the business of building. However, in some (but

***Australian Building Regulation and Liability Reforms** by Greg Lampert, prepared for Canadian Home Builders' Association and Canada Mortgage and Housing Corporation*

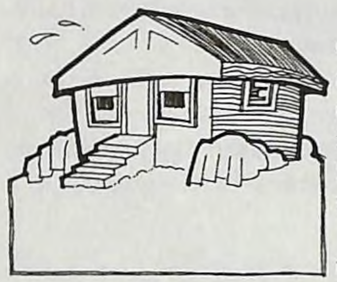
not all) states, restrictions have been placed on the activities of owner-builders to ensure that they are indeed legitimately building for their own occupancy and not using owner-builder status as a means of avoiding the regulations which apply to domestic builders. In the state of Victoria, for example:

Owner-builders cannot sell more than one home every five years;

Owner-builders who sell their homes within 6½ years of the issuance of the occupancy permit are required to provide a certificate of insurance to the purchaser for the remainder of the period; and

Owner-builders who sell their homes within the 6½ year period are also required to provide a report, prepared by a suitably qualified person - e.g. an architect or a building inspector, on the condition of the home.

Healthy Home Construction



Home construction has evolved dramatically over the years. While many houses today have amenities such as spas, electronic sensors, and elaborate security systems, they lack one important feature: indoor air quality. With high-tech progress in so many areas of our lives, why do we continue to be exposed to unhealthy air in our homes?

Houses are now being built much tighter than they used to be. In addition, many new synthetic building materials release dozens of chemical pollutants into the air. Older, leaky houses often had air blowing right through them, making them less than comfortable. Today's tighter homes require mechanical ventilation systems to provide a healthy exchange of air.

Studies continue to show that Canadians and Americans are vitally interested in improving their health. As a result, there is a growing demand for organically-raised foods, nutritional supplements, exercise equipment, and natural-fibre clothing. But most health-conscious people are unaware that poor indoor air quality is hindering their pursuit of the healthy lifestyle they so desire.

The indoor environment can have a significant negative impact on health. While it is within the ability of most contractors to build houses with good - almost pristine - indoor air quality, this is not being done often enough. It has been all too easy to ignore invisible pollutants that are inhaled on a regular basis.

Healthy House Building for the New Millennium by John Bower, is a revised, 3rd edition of the Healthy House Building book. It is written for anyone interested in improving his or her health when either building a new home or remodelling an existing one. There is a special emphasis on the needs of individuals who are highly sensitive or allergic.

Healthy House Building for the New Millennium takes you step-by-step through the construction of a model Healthy House. Every aspect of the design and construction process is covered, and a sample detailed set of house plans is included. This book covers issues such as off-gassing, ventilation and airtight construction, and offers practical solutions for every aspect of the building process. Seasoned R-2000 builders will find much of the information covers familiar ground, but will still find much of the information valuable and accessible.

Author John Bower is a builder who has been writing books and articles about healthy house construction for over a decade.

The Healthy House Video Series is a companion to the book. The video series (thirteen episodes, each just under 30 minutes) features healthy house experts John and Lynn Bower showing how to apply what they have learned over the years as they build their own healthy house. They go step-by-step explaining how each aspect of house construction process can affect indoor air quality.

These videos cover the entire design and construction process, taking the mystery out of healthy house construction. The video series does not have a lot of pizzaz. The videos cover the information very competently but occasionally come across as dull. Although production values are good, the series is low-budget. While many ideas are illustrated by reference to their house project, more could have been done. Some graphics to help explain concepts would have made this video series better. But despite these shortcomings, this is still a recommended series for those who want to become more familiar with healthy house concepts. This is a perfect video series for an in-house educational upgrading project.

Healthy House Building for the New Millennium: A design & construction guide *416 pages, $21.95*

The Healthy House Video Series. 13 episodes $99.95 total run time 5 hours 51.5 minutes.

Both the book and the video series can be ordered directly from The Healthy House Institute Web site at www.hhinst.com tel/fax 812-332-5073

Survey Shows Occupants of R-2000 Homes Are Healthier

It has been repeatedly claimed over the past few years that R-2000 homes provide a healthier environment for their occupants. Until now, these claims have been based largely on theoretical assumptions and anecdotal information. The problem has always been that the many variables in a home environment make it difficult to provide a scientifically conclusive analysis of the impact of the home environment on health. Yet, we know that a clean environment does contribute to good health.

We are now finally getting some conclusive, statistically valid information thanks to the results of a study underway for the past several years by Health Canada. Preliminary analysis of survey data shows that up to 30 percent of the occupants of R-2000 houses reported health improvements, with a reduction of symptoms of coughs, sore throats, fatigue, and irritability after moving into their home.

The survey, undertaken by Health Canada as part of the R-2000 Home Health Study, compared 50 R-2000 homes with 52 non-R-2000 control homes. These findings represent a statistically significant comparative difference. Health Canada will now expand the sample size and undertake additional field monitoring to help qualify the results.

Wanted: Proof of Envelope Failures in Energy Efficient Houses

There is considerable controversy, especially on the West Coast, that many building envelope problems are the result of, or made worse by, using energy efficient, air tight construction. R-2000 home technology has frequently been blamed.

We know there is a sound basis in building science for air tight, well-insulated construction. If built correctly, there should be no problems. The evidence suggests that where there are problems, they are the result of construction detailing errors. Blaming R-2000 may be a misunderstanding about what R-2000 construction entails. Program participants have not identified any building envelope problems directly due to air tight, well-insulated construction. This does not mean that problems can't occur. This is why we are launching an appeal: If anyone is aware of building envelope problems in an R-2000 home, or any home that meets R-2000 technical requirements (but may not be certified as such), please let us know.

We're requesting examples not only of West Coast houses, but also of buildings located elsewhere. Please provide information about the building, the nature of the problem and a contact that can give more details should the problem be investigated.

We'd like to offer a bounty for every problem building reported - but the budget is tight. However, by providing input you will be contributing to a better understanding of housing technology. And maybe helping to dispel some widely held myths!

Technical Research Committee News

Canadian Home Builders' Association

Ventilation Requirements

The proper application of the Building Code's ventilation requirements has been a major source of concern since the new code was issued. We have reported the continuing effort being made to draft revisions to the code language. A draft of revised code language has been prepared and is now being reviewed. It is hoped that, before too long, this will be issued as a revision to the Building Code.

A major issue is house depressurization. Measurements have shown that negative pressures as high as 100 Pascals were experienced in some new homes because of exhaust appliance operation. At such pressures, combustion appliances will spill combustion flue gasses into the house, creating potentially hazardous conditions for the occupants. This could be hazardous even if there is a heat recovery ventilator in the house.

Experience on the prairies has shown that combustion air ducts may have to be increased to 7 inches in diameter, as will fresh make-up air ducts. These enlarged ducts could create considerable discomfort for occupants. Efforts are also being made to contact the mechanical industry to clarify acceptable depressurization limits for new gas appliances, which would have a bearing on how much depressurization could be tolerated.

Since dryers are often the largest exhaust appliances dryers may have to be redesigned so they either lower air flows, are supplied with direct make-up air, or use a condensing technology that does not need to exhaust to the exterior.

Climate Change

Evidence is mounting rapidly that we are beginning to experience the effects of global climate change brought on by greenhouse gas emissions due to human activity. The buildings sector is one of the major consumers of energy directly affecting greenhouse gas emissions. CHBA has been a participant in discussions at Environment Canada's Building Round Table , which is attempting to develop a consensus approach to action in tackling gas emissions to meet Canada's commitments to the Kyoto agreement.

It is important to repeat how important action is, because there are still voices suggesting there is nothing wrong with global warming. The fact is that climate change will lead to more devastating natural disasters, including massive droughts and storms that will no longer be insurable; and coastal areas, entire islands and island nations will disappear as ocean levels rise.

Any energy conservation improvements that can be made, including more construction approaching or exceeding R-2000 performance standards for new and retrofit construction are moves in the right direction.

We need to remember that we are not only selling energy efficiency today, but also solutions to climate sensitive construction.

Code Requirements for Vapour Barriers

The Building Code requires effective air barriers and vapour diffusion retarders. It is more important that good, continuous air barriers be built than a continuous vapour barrier. Therefore, the Building Code does not require polyethylene to be used. As we have mentioned in recent issues, alternate means of providing vapour diffusion control that are not as vapour impermeable as polyethylene are acceptable.

We mention this because there is still considerable confusion on this issue, not only among builders and designers, but also building officials.

In-Ground Insulation

In the past, the Building Code limited the type of expanded polystyrene ("bead-board") foam insulation that could be used below grade. These limitations were drafted on the assumption that lower density EPS materials might be more likely to absorb moisture, and thus deteriorate. However, research findings have shown that all types and all densities of EPS materials are suitable for use below grade, so this requirement has been removed from the code. Now any type of EPS can be used below grade.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Effects of Light on Health

Light has a profound effect on our physiology in ways we are not aware of. We have been programmed by nature to rely on the sun, which is the energy source for most life processes on earth and the only natural source of light. Many claims are made about the effect of light, but there is still a lot we don't understand.

Light affects our moods, hormone regulation and daily behavioural and physiological rhythms which cycle with night and day. However, what the full impact light has not been definitively established. No doubt many studies will continue to be done, and many claims and counter claims will be made. Good access to natural light in our buildings is still desirable from a psychological as well as physiological point of view.

We can adapt to a wide range of illumination intensities and colours and can perform ordinary visual tasks at a great variety of light levels.

Light affects our health through the eyes and skin. Light in the visible portion of the spectrum affects receptors in the eyes that pass this information onto the brain. The non-visual effects of light may depend to a larger extent on the absolute light levels experienced. Light influences the skin itself (for example, tanning and allergic responses to light), as well as affecting the immune system and stimulating the production of vitamin D. Lack of adequate sunlight exposure may put some people at risk of developing vitamin D deficiencies.

Even at low intensities light can induce toxic or allergic responses in some sensitive individuals, especially those who have been exposed to environmental or medicinal chemicals which act as sensitizers to light.

Electromagnetic energy from the sun reaches the earth in a filtered form that still contains a broad range of wavelengths. These include high-energy wavelengths not visible to us, the ultraviolet (UV) range, medium-energy radiation that forms the visible spectrum, and low-energy radiation in the infrared range that is experienced as heat.

There has been considerable debate about the quality of light inside buildings, and the effect of different types of glass. Some people are more affected than others by adequate light levels. Older people are particularly vulnerable.

Tinted and coated window glass can screen or filter some wavelengths of light as well as reducing general illumination levels, thus increasing the use of artificial lighting indoors. But the reduced light and altered perceptions of brightness from tinting encourages the use of additional artificial lighting.

Ordinary window glass has little effect on wavelengths in the visible spectrum or the infrared range, but drastically reduces UV wavelengths below 380 μm.

Those of us who live at more northerly altitudes with short winter days may be more prone to suffer from light deprivation. Seasonal affective disorder (SAD) is a regularly recurring depression associated with the short days of autumn and winter. It appears to be more prevalent as one moves northward away from the equator, and is more common in women than men. This type of depression can be treated by increasing artificial light exposure during the winter months.

Field studies of the effects of different lighting systems, including "full-spectrum" fluorescent lighting, altered the spectral characteristics resulting from window tinting, and windowless environments have not provided definitive answers. Most studies are incomplete or so poorly done as to not permit any firm conclusions.

Testing for the effects of light is difficult to do, as scientific test procedures include the use of a placebo or a 'blind' control. However, it is difficult to administer a placebo to which therapeutic light effects can be compared without the patients' awareness of the difference. Light effects may be mediated in part by patients' beliefs and expectations.

Windows have a profound impact on how people experience a room. In new buildings quality of lighting, ventilation and temperature control are of most concern.

People want a view to the external world; a sense of contact with the outdoors; a positive feeling when seeing sunshine; and the warmth and "atmosphere" provided by sunlight in certain rooms at certain times of day.

While most people find desirable the sunlight windows allow to enter, and the view, there are

Lighting and Human Health: A Review of the Literature, for: Canada Mortgage and Housing Corporation. B.Rusak, G.A.Eskes, S.R.Shaw

limitations. Enthusiasm for large window areas has to be tempered by the negative effects of sunlight, which depend on climate and season. Large glass surfaces can overheat in summer, and cool in winter. In addition, fading of fabrics exposed to sunlight, glare, and privacy also impact preferences for large windows.

"Full spectrum" electric lighting is often proposed to compensate for lower light levels, and the light that is filtered out by windows. Full-spectrum lighting is a vague concept, often used to describe UV-supplemented fluorescent sources. Claims have been made that UV-supplemented light improves performance, mood or health in the general public. But there is no data to support these claims of beneficial effects for UV-supplemented or full-spectrum lights.

It is also important to note that no fluorescent lighting spectrum is the equivalent of natural sunlight. In fact, it is difficult to define a single spectrum for sunlight because it varies considerably with the time of day and season of the year.

Evidence of Direct Health Improvements Due to Natural Light Not Conclusive

Recently, several studies have investigated the effects of light. Although the studies received a lot of attention, their findings were not conclusive.

A study on children in school classrooms comparing full-spectrum and "cool white" fluorescent failed to find any significant effects on school performance. There was a reduction in "hyperactivity" in the full-spectrum classrooms. Unfortunately, the study was flawed in its design so definitive conclusions about the effects of the lighting on the children's behaviour cannot be drawn from it. It is possible that UV supplementation has beneficial effects, but the study does not provide enough evidence for it.

The numbers of students and classes studied were very small, and the study's report did not note whether the classrooms had windows, or how much time students spent exposed to natural illumination during the day.

Another, higher profile study (referenced in Solplan Review No. 81, July 1998) looked at five schools in Alberta over a two-year period. Claims were made that the children's school performance, attendance, and rates of physical development improved and dental disease was reduced as a result of substituting full-spectrum lights for other types of lighting in the classroom.

This study also was seriously flawed in its design, execution and analysis, so reliable conclusions cannot be made based on it. From a scientific perspective, a number of significant questions were not considered which could have provided significant information.

For example, how big a factor was pre-existing social or economic differences among schools? Did all the schools have recess outdoors? Was recess held twice daily? Did children go out at lunchtime? What was the pattern of natural light exposure at other times of day? In the sunny (but cold) Alberta winter, what proportion of UV exposure came from daylight during recess, lunch and the rest of the day compared with the hours of exposure to very low UV levels in the classroom from all full-spectrum light sources? If classroom exposure was only a small proportion of the total daily exposure, it is improbable that it would have any effects such as those claimed. The study addressed none of these issues, which were crucial to interpretation and design of any future studies on this topic.

Star Heat Exchangers: Where are they now?

Ventilation has been an integral part of planning from the earliest days of energy efficient new home design in Canada.. Heat recovery ventilators and continuous ventilation were promoted not only to obtain best overall energy performance, but more importantly to ensure good indoor air quality,. Many entrepreneurs stepped into the breach, and at one time there were more than a dozen manufacturers. Over the years, some folded, others merged and so today only a few manufacturers dominate the market.

One company that had some innovative products, and had carved out a niche for itself, was Star Heat Exchangers, based in Port Coquitlam, BC. Recently, we have been asked about their whereabouts, because homeowners with Star HRVs are looking for sources of replacement parts.

We know that, in the late 1980s, Star Heat Exchangers moved their operation to Newfoundland, but they seem to have faded from the map (or sunk into the cold, fog shrouded Atlantic). We would appreciate hearing from anyone who knows if there is a successor business that is able to supply parts. Alternately, is there anyone out there that has taken on, as a cottage industry, the servicing of these orphaned equipment systems?

Concrete Construction

Homebuilder and home buyer interest in concrete homes has increased in recent years. The Portland Cement Association reports that, in 1998, almost 125,000 homes in the USA were built using concrete systems, including insulated concrete form systems (ICFs) and concrete masonry. Concrete's market share rose to more than 10%, a 350% increase since 1993.

Market research shows the most American builders believe home buyers are willing to pay 2% to 5% more for a concrete home than for a wood-framed one. Reasons for this increased interest include: the benefits of pest resistance, soundproofing, energy efficiency and the strength and safety of concrete walls.

Durability of Radon Remediation

Since the presence of radon inside houses was discovered some years ago, remediation methods have been fine-tuned. But how effective are the remediation methods over the longer term? A Swedish investigation looked at the effect of radon remediation in buildings that had been decontaminated in the 1980s. Radon measurements in half of the single-family houses were 30% found to be higher than immediately after decontamination; in one quarter of the houses the radon was more than twice as high. In addition, in 10 out of 12 apartments in multi-family buildings had radon levels exceeding the threshold limit, mainly on account of deficiencies in the maintenance instructions.

You Wonder Why Your Skin Cracks in January?

Relative humidity is the percentage of moisture in the air compared to its maximum capacity to hold moisture under the same conditions. Air at an air temperature of 21°C can hold more than 12 times as much moisture as air a -12°C. Outdoor air at –12°C and 70% relative humidity drops to 7% relative humidity when heated to normal room temperature.

The average humidity in the Sahara Desert is 25%; in Death Valley it is 23%. The average Canadian home can have a winter indoor relative humidity level of 13 to 16% unless moisture is introduced.

Coming Events

Feb 13-16, 2000
CHBA's 57th National Conference
Ottawa, ON
Tel: 905-954-0730
Fax: 905-954-0732

Feb 22-23, 2000
Building a High Performance Home
Green Bay, WI
Tel: 724-852-3085
Fax: 724-852-3086

Feb 29-March 1, 2000
Home Builder & Renovator Expo
Seminars & Trade Show
Vancouver, BC
Tel: 604-739-2112
Fax: 604-739-2124

March 9-12, 2000
World Sustainable Energy Day & Trade Show
Wels, Austria
Tel: (43)-732-6584-4380
Fax: (43)-732-6584-4383
www.esv.or.at

March 23-25, 2000
CMX (Canadian Mechanicals Exposition)
Toronto, ON
Tel: 416-444-5225
Fax: 416-444-8268

April 3-8, 2000
AffordableComfort Conference
Columbus, Ohio
Tel: 800-344-4866
Fax. 724-223-7754

Apr 7-8, 2000
CIPHEX West 2000
(Plumbing & Heating Show)
Calgary, AB
Tel: 416-695-0447
Fax: 416-695-0450
www.ciph.com/ciphex/

May 11-13, 2000
Interbuild 2000
Housing and Construction Show Toronto, ON
Tel: 888-922-3600 (toll free)
Fax: 780-413-6224
e-mail: info@interbuild2000.com

Renewable Energy Education Variety of courses on photovoltaic system design and installation, micro hydro, wind power, passive and active solar. Most in Carbondale Colorado. For detailed schedule and course outline: Solar Energy International. Tel: 970-963-8855; Fax 970-963-8866; www.solarenergy.org

Energy Answers

Rob Dumont

Has the air tightness of houses improved very much over the years here in Canada?

Definitely. Here are some air tightness numbers for groups of houses in Saskatchewan:

The R-2000 standard is 1.5 ac/h at 50 pascals,

Age of Houses	Air Tightness *(air changes per hour at 50 pascals)*
Pre-1945	10.4
1946-60	4.5
1961-80	3.6
Current	2.0

and new houses in Saskatchewan are now averaging about 2.0 ac/h at 50 pascals.

The STAR database on housing developed by CMHC and NRCan has similar air tightness data on groups of houses across Canada. The general trend of improved air tightness for new houses over time holds across the country.

How tight are commercial buildings? Has their air tightness also improved?

Although Canadian houses have greatly improved in air tightness, it is not at all clear that similar improvements have been made with commercial and institutional buildings.

Much less information is available on the air tightness of commercial buildings. It is considerably more expensive to perform an air tightness test on a large building than on a house. The Institute for Research in Construction at NRC in Ottawa has a large fan system that can handle major buildings, but the unit is so large it needs a special trailer-mounted fan with a dedicated diesel engine to drive the fan.

The Canadian General Standards Board has recently developed a standard that outlines how to pressure test a larger building using the ventilation system.

With commercial buildings, the units of measurement for air leakage that are favoured here in Canada tend to be the air flow per unit building envelope area at 75 pascals, while the residential units of choice are the air changes per hour at 50 pascals.

Back in 1976, George Tamura and John Shaw of the NRC published a very useful paper on the measured air tightness of some Canadian office buildings with sealed windows. The buildings ranged in air tightness from 0.6 to 2.4 litres/second per square metre at 75 pascals. Based on these measurements, they developed the following classification for buildings:

Building Air Tightness Classification	Litres/second-square metre at 75 pascals
Tight	0.5
Average	1.5
Loose	3.1

I did some calculations to see how the classification system developed by Tamura and Shaw would correspond to the air tightness classifications we have for houses. I took a house with an air tightness of 1.0 air changes per hour at 50 pascals, a volume of 500 cubic metres and a surface area of 405 square metres. Assuming that the types of holes in the house are typical of normal houses, I calculated that the house would have an air leakage rate of 0.44 litres/second per square metre at 75 pascals, which would correspond to a tight building using Tamura and Shaw's classification.

The classification systems for both houses and commercial buildings are thus generally consistent for Canadian buildings. A tight house (1 ac/h at 50 pascals) would also be a tight building (0.44 $L/(s\text{-}m^2)$ using the Tamura and Shaw classification system.

Recently, some data on the air tightness of commercial buildings was published in the ASHRAE Journal (March, 1999). The author, Andrew Persily, pulled together the results of envelope air tightness data for 139 commercial and institutional buildings in four countries (U.S., U.K., Canada, and Sweden.) The tightest building in the survey had a value of 0.75 $L/(s\text{-}m^2)$ at 75 pascals, the average was 7.5, and the leakiest was 34.5 $L/(s\text{-}m^2)$ at 75 pascals. Using the scale developed by Tamura and Shaw, none of the 139 buildings would meet the "Tight" classification of 0.5 $L/(s\text{-}m^2)$ at 75 pascals.

One of the observations from Persily's study was that "the commercial buildings that have been evaluated are not particularly airtight relative to U.S. houses and some are quite leaky."

A second observation from the data was that "there is no suggestion that newer buildings are tighter." A third observation was that "among four sets of data of office buildings, the mean air tightness values are lowest in the Canadian buildings..."

The 1995 National Building Code of Canada in Appendix 5.4.1.2 recommends an air tightness value of 0.15 $L/(s\text{-}m^2)$ at 75 pascals for buildings with the indoor relative humidity less than 27%. As can be seen from the Persily data, none of the buildings came close to such a value. The tightest building in Persily's study was 0.75 $L/(s\text{-}m^2)$ at 75 pascals, or 5 times as leaky as the suggested standard of 0.15 $L/(s\text{-}m^2)$ at 75 pascals. Commercial buildings have a long way to go.

What do all these figures mean? In summary, commercial buildings are leaky, and for the most part newer buildings don't appear to be getting any tighter.

In Canada there has been a greater focus on air barriers and air barrier technology, and it is possible that we will do better now that superior air barrier technology is being applied.

We definitely need more measurements. Here in Saskatchewan, in the past year we pressure tested some older commercial and institutional buildings. The average air tightness for the 7 buildings was 1.5 $L/(s\text{-}m^2)$ at 75 pascals, which agrees exactly with Tamura and Shaw classification for average tightness. The tightest building in the survey was a one storey institutional building built in the 1950s that came in at 0.8 $L/(s\text{-}m^2)$.

We also pressure tested the C-2000 Alice Turner Library, completed in 1998 here in Saskatoon, and it had a truly tight envelope: 0.09 $L/(s\text{-}m^2)$ at 75 pascals. It may be the tightest commercial building in the world.

May there be many more buildings built to similar levels of tightness!

Computer Warning

We've lived through the Y2K hubbub with relative ease. However, we would like to warn you about a much more serious computer problem. If you are planning on purchasing a new computer or upgrading your existing computer, you can save yourself a lot of grief by avoiding Microsoft's Windows 98 operating system.

Contrary to all the hype, this system will cause you plenty of grief. In my opinion, they are selling this software under false pretenses - it should be considered as a "Beta" version, and not as a finished product. It is especially a concern because unlike normal stand alone software, it drives everything else on your computer. We upgraded our main computer, and have not had a day where the computer would not crash randomly.

I'll spare you the litany of problems we've encountered - it's just too long and doesn't fit here. This word of warning is provided in the hope it may avoid the frustration and aggravation we've just gone through. After three months I've finally given up, and gone back to Windows 95 for the operating system - it may not be perfect, but at least it's reasonably stable and won't crash as often.

NRC·CNRC

Basement Insulation Research Uncovers Some Surprises

By Will Koroluk and Mike Swinton

A study done at the Institute for Research in Construction (IRC) has shown a high degree of stability in the thermal performance of insulation installed on the exterior of basement walls.

The study, carried out with five insulation products configured into 13 different basement insulation systems, showed that the performance level was maintained even during major rain storms and winter thaws, when water reached the outer face of the insulation. This was contrary to researcher's expectations. They had expected the R-value of the insulation to decline, especially if water were to move through the insulation.

The study was done because major basement failures in new homes have been a frequent source of claims for new-home warranty programs. When failure occurs, rectifying the situation is usually expensive. Not only does the foundation itself need to be repaired, but other elements have to be considered as well. Items such as eavestroughs, proper grading, wall and footing drainage, for example, all add to the cost.

Thus, IRC launched a research program in collaboration with industry partners to see how exterior basement insulation systems perform. Members of the research consortium, besides IRC, were the Canadian Plastics Industry Association, the Expanded Polystyrene Association of Canada, the Canadian Urethane Foam Contractors Association, Owens Corning Inc., and Roxul Inc.

The types of insulation tested were expanded moulded polystyrene (EPS) Type I, EPS Type II, spray-polyurethane-foam (SPF), mineral fibreboard and glass fibreboard. By using a variety of installation approaches, joining techniques and other factors, researchers ended up with 13 different systems.

It should be noted that before 1999, the National Building Code of Canada prohibited use of EPS Type I in contact with the ground for houses and small buildings. Late in 1998, however, the restriction was removed, a move that is validated by the results of this study.

Until now, designers and builders had little factual information about how the insulation they specified would perform when placed on the outside of a basement wall in contact with the soil. This study—which ran through two heating seasons—has provided some answers.

It also shed some light on how these systems manage water.

This was an important part of the study, because at least one provincial building code specifically refers to fibrous products as having acceptable characteristics for providing drainage. Research confirmed that this approach works for both mineral fibre and glass fibre specimens. But the rigid boards and the spray-foam product successfully excluded water from the basement wall system as well, leading to the question: Are voids for drainage necessary for water management?

The short answer is no.

Researchers investigated several specimens wrapped in two layers of polyethylene, forming smooth surfaces with no drainage space. They found that these promoted water movement at the outer surface so the water did not penetrate into the basement wall system.

Grading the soil around the basement so there is shallow slope away from the wall is a fairly conventional way of helping keep water away from the wall. But researchers found it couldn't be counted upon. They created a five-per-cent slope away from one wall during the final landscaping (after a full winter and spring of soil settlement, and a five-per-cent slope toward another wall).

The grades were measured again at the end of the experiment. It was found that soil subsidence had resulted in slopes toward both walls. The apparent advantage of a slope away from the wall as a primary means of water diversion had been lost in just one year. This led them to conclude that either steeper initial grades or other, more reliable means of water diversion are needed.

The tests were done on a test house on IRC's Ottawa campus—not at one of the houses built for the new Canadian Centre for Housing Technology, but at one of the older houses still used as test facilities.

The study concluded that all the products tested delivered similar and sustained thermal performance, although, as expected, the SPF product delivered more R-value for the same thickness. They also all delivered good water-management capabilities, although using different methods.

It was also found that it is important to avoid thermal bridging. Even limited contact with another thermally conductive element such as concrete can have a significant impact on the thermal performance of the entire wall system. A protective covering plays an important role at and just below grade, where freeze-thaw action is probably most severe.

Drainage grooves in rigid insulation board have been added by manufacturers to provide vertical air spaces between the insulation and the foundation wall to relieve potential water-pressure build-up. These may not be necessary, and should be re-examined.

Will Koroluk is an Ottawa-based freelance writer specializing in building science. Mike Swinton is a senior researcher and project manager in the Building Envelope and Structure Program of the National Research Council's Institute for Research in Construction. He is also research manager of the Canadian Centre for Housing Technology. He can be reached by phone at (613) 993-9708 or by e-mail at mike.swinton@nrc.ca

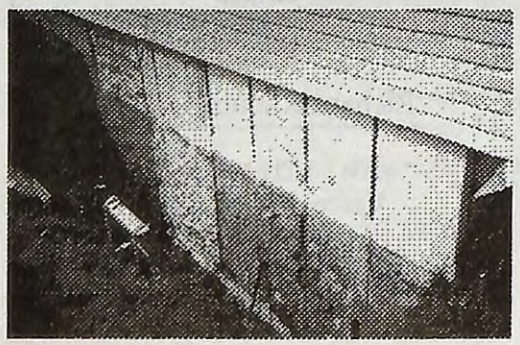

Photo of six of the exterior basement insulation specimens just before removal after 2 ½ years in ground.